OHIO DEPARTMENT OF ENERGY

1980 ENERGY STATUS REPORT

To be submitted to:

GOVERNOR JAMES A. RHODES

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Robert S. Ryan, Director

INTRODUCTION

As required by Section 1551.04 of the Ohio Revised Code, the Ohio Department of Energy prepares and submits an Annual Status Report identifying emerging trends related to energy supply, demands, progress in conservation, public health and safety factors, costs of energy to the consumer, and specifying statewide and regional energy needs.

The concerns about petroleum supplies which were so apparent just one year ago have abated significantly. At the time of the submission of this report, gasoline and crude oil stocks in the U.S. are standing at record high levels, thus we anticipate no supply problems for gasoline, diesel fuel, home heating oil and other fuel oils used by commercial and industrial customers.

Natural gas supplies are also adequate for a winter that would be 10 percent colder than normal. The curtailments to industrial customers of several years ago do not appear to be a threat for the coming year. Per capita consumption of residential natural gas is lower due to the conservation and weatherization efforts by homeowners in the state.

Electric generation capacities in the state are adequate to the anticipated demand, and although the electric utilities in Ohio have been hard hit by rising costs of money and construction, the reduced rate of demand growth allows them to delay construction of new facilities for a significant period of time without affecting the reliability of service to their customers in all sectors.

Demand for all types of fuel is rising at very reduced rates. This is attributed to greater observance of conservation and the general economic slowdown being experienced in the state and across the nation. The conservation, we believe, is a result of the rapidly escalating prices of all forms of energy. The people are responding to the pocketbook impact of this cost increase by conserving rather than to any patriotic or emotional plea.

Prices of all forms of energy have increased dramatically over the past two years. Home heating oil prices are up 10 percent in June, 1980 over December, 1979, and up 78 percent over December, 1978. Residential electricity rates are up by 30 percent, and residential natural gas prices are up over 50 percent since December, 1978. We believe the conservation efforts are a result of thes price increases.

This report contains a vast amount of summary statistics for supply, demand and state production of all forms of energy. The Department maintains files and records far beyond the scope of what has been presented in this report, and we encourageinquiries for additional energy data of any sort should a need for this information develop.

TABLE OF CONTENTS

NATURAL GAS.....1

COAL.....8

ELECTRICITY.....16

PETROLEUM.....22

CONSERVATION.....30

ALTERNATIVE SOURCES.....38

TABLES.....47

NATURAL GAS

NATURAL GAS

Ohio consumers use natural gas for roughly 30 percent of their total energy needs. (See Table 6). Ohioans will continue to depend on gas for a substantial share of their energy throughout the rest of this century. Therefore, it is imperative that reliable natural gas supplies be assured to meet Ohioan's future needs.

The principal thrust of the 1979 Report is still true: "the cheapest and most secure sources of gas are those closest to home." Consequently, the State should do everything it can to support development of Ohio's own natural gas resources. The events of the past year have strengthened this position.

The 1979 Status Report suggested that the largest single factor influencing future Ohio gas supply and demand was the Natural Gas Policy Act of 1978 (NGPA). NGPA extended existing federal wellhead price control authority to Ohio-produced as well as interstate gas, while gradually decontrolling the price of all gas. By 1985, all gas wellhead prices would be completely decontrolled.

Events of the past year have shown that phased deregulation is having the desired effect. Nationwide, exploration and drilling activity increased 6 percent in 1979 over 1978 figures after having decreased in preceding years. This increased activity did not eliminate the decline in proven natural gas reserves for the total U.S. However, the loss in 1979 was the lowest since 1970. The industry expects additions to reserves to exceed the volumes taken from reserves in the next two to three years.

In Ohio, 1979 drilling activity, additions to reserves and production reached new peaks. This high level of activity has continued in 1980.

In 1979, future natural gas supplies appeared so plentiful that Ohio gas distribution utilities applied to the Public Utilities Commission of Ohio (PUCO) to rescind its ban on new customer service connections which had been in effect since 1973. The PUCO did rescind its action with the provision that Ohio utilities increase to the extent possible their future supplies from Ohio sources in proportion to their increases in customer service.

In late 1979, Ohio gas utilities projected that future Ohio gas demand would grow modestly over the next 10 years, at an overall rate of less than 1 percent per year (ODOE-SGS, 1979). Growth after 1984 would occur at a slightly higher rate than growth before 1984. The reasons for this low growth rate include increased conservation by all sectors and lower population growth. However, a disturbing aspect of Ohio utilities' projections is the level of their anticipated purchases of Ohio produced gas. The utilities project that their supply share coming from intrastate Ohio production will actually decline slightly over the next ten years. They project that utility purchases of Ohio gas will only be 3 percent greater in 1989 than they were in 1979.

The lack of intrastate pipeline capacities is the basic reason for the low forecast. Additions to the intrastate pipeline system would provide a greater increase in utility take of locally produced natural gas and sustain the "self-help" industrial natural gas program.

As of today, however, gas industry forecasts of gas supplies project an increasing reliance on "supplemental" unconventional sources of gas through the 1980's. These supplemental sources include imported liquified natural gas (LNG), synthetic natural gas produced from liquid petroleum gases (SNG), gas synthesized from coal and wastes, and gas recovered from unconventional

in-ground sources. Associated with the production and transportation of each of these supplemental sources are uncertain degrees of risk and very high consumer product costs in comparison with proven Ohio natural gas sources. The extent of this uncertainty can be seen in comparison of the American Gas Association's "High Supply" and "Low Supply" forecasts for supplemental sources as shown in Table 18.

The supplemental sources in the low supply forecast are a full 72 percent lower than in high supply, or 18 percent of potential total supply in 1990. Under the low supply scenario, roughly 20 percent of demand would go unmet, which would undoubtedly require industrial consumer curtailments.

The 1979 Status Report discussed one of these supplemental sources already being used - imported LNG. Concern was expressed over the increasing volumes of gas being supplied from Algeria, an OPEC petroleum producer. Roughly 6 percent of Ohio supply (Table 16) in 1979 came from Algeria through the Cove Point, Maryland LNG re-gasification facility.

Events in early 1980 proved Algerian LNG to be no more reliable as a future Ohio energy source than any OPEC country's petroleum supplies. Algeria decided its gas price was not high enough, although the Algerian price had risen from 37¢/mcf at the wellhead to $1.95/mcf in two years. Algeria wanted the price of its gas, delivered to liquification units in Algeria, to be priced at a level equivalent to the Btu cost of alternative petroleum products delivered to the end user. This would make the price of gas to an Ohio end user between $8-9/mcf. USDOE's economic regulatory administration would not approve an import license at this price, so new negotiations began between all parties. In the Spring of 1980, Algeria cut off all gas exports. At the time of this report, price negotiations continue and the supply continues to be cut off.

Circumstances such as these would seem to indicate possible future problems with some of the supplemental sources, which are less reliable than Ohio produced gas.

Ohio gas availability is not uncertain. Over 90 percent of wells drilled in Ohio are productive. Also, estimates of costs for supplemental sources show their prices to be much higher than wellhead gas prices in Ohio. At this writing, Ohio produced natural gas carries a well head price of $2.25 to $2.35 per Mcf, about 1/3 the probable new cost of Algerian LNG and half the price of Canadian and Mexican gas.

Yet the interstate gas pipeline companies serving Ohio distribution utilities now purchase Canadian and Mexican imports at $4.47/mcf to "supplement" their gas supplies. They continue to plan large purchases of expensive LNG, while they concurrently plan to purchase less Ohio gas, even after federal price controls over locally produced gas are removed in 1985.

The state may find a role to play in trying to overcome either of these apparent barriers to increasing pipeline and distribution utility purchases of Ohio produced gas. The state may seek to change Federal regulatory procedures which force Ohio gas to compete against the artificially low-priced gas sold to distribution companies by interstate pipeline companies.

As stated in last year's Status Report, a most effective way to increase utilities' Ohio gas purchases would be for Federal Energy Regulatory Commission pipeline price regulations to be changed to allow a utility to substitute Ohio gas for a share of the high-priced gas it receives as a portion of interstate supply. Distribution utilities would then pay a lower overall cost for their gas supply and Ohio gas producers would receive the appropriate federal regulatory ceiling price for their gas.

In conjunction with seeking more favorable federal regulatory treatment of gas purchase pricing prodedures, the state should take advantage of opportunities to reduce pipeline company acquisition costs for Ohio gas. This might be accomplished by the state's helping Ohio producers form cooperatives or some other aggregation which could contract with pipeline companies for large volumes of gas over long periods. A pipeline company not having to deal with myriad small producers could substantially reduce its overhead acquisition costs. The state might also aid in financing gathering lines or compressor stations, or provide other assistance to enhance transactions between producers and potential gas purchasers.

The third part of the answer to the question posed above concerns individual industrial (or occasionally commercial) "self-help" users who drill their own wells or buy gas directly from a producer. This type of arrangement became popular during the pipeline gas supply curtailments of 1975-1979 (See Table 19). Self-help will become even more attractive as decontrol proceeds. As supplemental gas sources increase in quantity and price, utility pipeline gas will cost more and more. Thus, a price disparity will develop between utility gas and Ohio "self-help" gas, making the self-help option more attractive.

The principal constraints on self-help currently are the capacity of the utility pipelines and the cost of transporting gas from the wellhead to the user. Reducing the cost of transportation offers a third possibility for state involvement to increase use of Ohio gas. In 1979, the Ohio industrial sector showed an estimated 3.6 percent increase in gas usage over the previous year. Under stable economic conditions industrial use should grow at an annual rate between 2 percent and 3 percent over the next five years or so. Ohio producers have the capacity to supply a substantial portion of this need.

Self-help gas can be transported to users in one of two ways: feeding the cutput of a well into a utility line while the self-help user draws an equal amourt of gas from the utility at its plant site, or piping the gas directly to the user through private pipelines. The first method is dependent upon excess capacity in the utility's pipeline. The second method becomes expersive over long distances, particularly when easements must be obtained across many landowners' property. The state may be able to help to reduce these transportation costs for individual self-help gas users through efforts to form grcupings of self-help users or would-be users located in the same area.

A large volume pipeline could be built from the producing area to serve such adjacent users. The pipeline's cost would be borne by all the users, but would capture econcmies of scale and thereby reduce costs to all concerned. The state might also help further reduce pipeline financing cost for producers and users through issuance of low interest revenue bonds.

All of these initiatives would benefit Ohio gas utility customers by holding down the price of gas tc Ohio utilities, as well as increasing total Ohio supplies. There is real opportunity for Ohio produced gas to be more of a factor as a future supply source for Ohioans. However, initiatives must be undertaken ncw to assure incorporation of large volumes of Ohio gas into our supply stream. Immediate state efforts are especially important to remove existing federal regulatory constraints on the purchase of Ohio gas and to facilitate new pipeline construction for the transport of Ohio gas.

Ohio gas consumer prices will begin to rise steeply as federal price controls are removed on high cost "supplemental" gas supplies unless tempered by increased Ohio prcduced gas supply increases. If Ohio's pipeline and

utility supplies continue to perceive a lower acquisition cost for their purchases of higher priced gas than Ohio gas, they will enter into long term supply contracts for this gas. Once long term contract commitments are made, it will be exceedingly difficult for Ohio produced gas to displace this expensive gas. It is imperative to find ways for enhancing utilities' Ohio-produced gas supplies as soon as possible.

COAL

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In 1979, Ohio industry used 20.6 million tons of coal for 30 percent of their total energy needs (See Table 3). Ohio's electric utilities used 51.7 million tons, 95 percent of the fuel needed for power generation. Ohio's substantial dependence on the use of coal will continue for the foreseeable future. At projected levels of consumption, Ohio has more than ample coal reserves for the next several hundred years to meet all coal-based Ohio energy needs. (See Table 9).

However, despite the abundance of available Ohio coal supplies, Ohio industry and electric utilities continue substantial increases in their use of non-Ohio coal. (See Table 11). This stagnant consumer demand for Ohio coal (Table 13) in an increasing national coal market primarily arises from federal air quality regulations which make would-be users of Ohio coal uncertain of its potential total cost compared to other fuel sources. The federal Environmental Protection Agency (USEPA) keeps changing its Ohio coal combustion air quality regulations. The uncertainty created by USEPA's regulatory inconsistencies has deterred the use of Ohio coal.

Ohio's economic base is quite vulnerable to this uncertainty. The largest coal users in Ohio - the electric utilities and primary metal, chemical, stone, clay and glass industries - have highly specialized production processes which are equipment and energy intensive and systemically integrated to maintain competitive efficiencies. Major changes in their processes take long lead times and substantial capital investment. Ohio's economic productivity and employment levels have already been constrained by USEPA's stringent regulations

on Ohio coal combustion. Meanwhile, dozens of smaller Ohio coal producers have simply gone out of business in the last several years.

Industrial process changes, such as coal combustion-pollution abatement innovations, are best made in small increments at the time when equipment and plants need to be replaced. This suggests air quality regulations should allow ample time for pollution abatement innovation and economical replacement of existing physical plants.

USEPA's imperious insouciance has already caused some major Ohio industrial and utility coal users to make permanent commitments to non-Ohio coal supply sources. Many Ohio industries can no longer postpone the replacement of worn out coal-using equipment and will ultimately decide to replace it with equipment that will use oil or natural gas or out-of-state low sulfur coal. Once this equipment is installed, that potential purchaser of Ohio coal is usually lost for the life of the equipment, because boilers designed for out-of-state coal cannot easily burn Ohio coal without virtually doubling their investment in pollution control equipment.

USEPA and Ohio Coal: The Confrontation

The discussions between USEPA and Ohio EPA concerning the use of Ohio coal have reached battleground proportions and have received widespread publicity in all media. While we do not intend to dwell heavily on this confrontation, the Ohio position and proposals have been argued against and refused by the federal government which has been upheld by the Courts.

A few of the proposals are worthy of review. For one, Ohio EPA submitted a plan in August, 1979, calling for 30-day averaging of stack emissions by which to judge compliance. This measuring tactic would recognize the variance in sulfur content in coal seams, which can vary by 25 percent from location to

location within a seam. A seam in compliance over a 30-day measurement time would certainly be in violation during several 24 hour periods in a 30-day month. Other states are under 30-day averaging, but Ohio was only granted a "temporary" 30-day averaging plan until the first quarter 1981. This means that high volume coal purchasers would have to buy on expensive short term contract or on the spot market for their coal needs. Their experience with USEPA led to an uncertainty about the future which induced their entering into long term contracts for western coal.

Another USEPA case concerns two generating plants of an Ohio electric utility. Upon application and negotiation, those plants were reclassified to permit higher emission levels which allowed them to burn Ohio coal blended with low-sulfur coal. The utility signed a supply contract with an Ohio coal operator who refurbished and modernized the mine to meet the contract. Within months the courts, on appeal, reversed USEPA who fought but feebly. The contract for Ohio coal was cancelled, the operator lost his investment and the miners are out of work again.

Another significant USEPA-imposed deterrant to increased industrial use of Ohio coal is the time frame set by that agency by which the ambient air quality standards must be met. Little or no understanding of the time necessary for capital formation or construction was demonstrated in the establishment of the standards and compliance schedule. Many companies which had been burning coal took the "safe" way out and switched to oil and natural gas. Having switched at enormous cost, they are helpless in watching their cost of production rise because of the rising costs of these fuels. They are also unwilling to return to coal because of the vagueries of the USEPA or because of the capital costs involved in re-retrofitting their equipment.

Recently, a rising question is the validity of the standards set and administered by USEPA. The first USEPA Administrator under whose guidance the original standards were set, Mr. William Ruckelshaus, has publicly acknowledged that the standards were set with no verified information of any medical or scientific nature. He has said that the standards were set arbitrarily without regard to need or with a cost-benefit analysis. He, along with a growing number of professionals in the field, have called for a review of the standards form a scientific basis using full medical data and expertise. There is rising doubt that some of the so-called culprit emissions are really causing the harm attributed to them.

When all of the existing clouds settle and all controversies are resolved, there will remain the need to use some technology to utilize coal, and Ohio coal will remain a problem because of its basic characteristics. Sulfur removal is the principal problem.

The federal government through USDOE has given high budget consideration to coal, but this effort has been mainly in gasification and liquefaction. Little, or in our opinion, not enough consideration has been given to the direct utilization by combustion of coal, particularly high sulfur coal.

Thus, by default, Ohio has taken a lead position in coal beneficiation for direct utilization. Coal washing by conventional and newly developed techniques is being expanded in Ohio to make greater use of this resource.

Substantial research is continuing on technologies to burn Ohio coal while meeting appropriate air quality emissions levels. These research projects center on removing sulfur from coal and can be done prior to, during and/or after combustion.

ODOE's principal coal combustion research continues to focus on fluidized bed combustion (FBC) systems. Two demonstrations of full scale FBS systems at atmospheric pressure are currently underway, one at Georgetown University in Washington, D.C. and the other at the Central Ohio Psychiatric Hospital in Columbus. The installation in Columbus is the first totally state-funded FBC facility in the nation, with no federal funding or other assistance involved.

This facility and the Georgetown project will prove this technology will allow the burning of high sulfur coal in an environmentally acceptable manner. However, these are relatively small boilers which would find application in commercial and small industrial facilities.

While current technology is applicable to large commercial or small industrial boilers, up-scaling through other planned future demonstration projects is expected to be successful for utility and large industrial facilities.

Experience with wet scrubbing of stack gases is growing. There are now six scrubber installations which report availabilities of 85-97 percent. These tend to be units that clean the emissions from relatively low sulfur coals. Nevertheless, wet scrubbers have not yet proven to be completely reliable on Ohio high sulfur coal.

Dry scrubbing is a promising new technology currently being tested. No utility-sized facilities have yet been installed and operated for significant lengths of time, so actual field experience is limited. Even so, dry scrubbers are planned for three new Ohio electric power plant units by 1983. Dry scrubbing offers the advantage of producing a dry waste which can be more readily disposed of than sludge from wet systems.

Non-regenerable dry scrubbing, however, appears to have one important limitation: it might only be economically feasible for plants with SO_2 concentrations in the flue gas, due to its use of expensive absorbents such as soda ash, lime, and trona-nabcolite.

Coal Gasification and "Synfuels"

In June, 1980, the President signed into law a national synthetic fuels program. The law authorized $20 billion to start the program aimed at producing 500,000 b/d equivalent synthetic fuels by 1987 and 2 million b/d by 1992. It also authorizes direct loans and loan guarantees for synthetic fuel plants, and price guarantees for their products. The law establishes a U.S. Synthetic Fuels Development Corporation to build its own plants if private industry is unable.

Meanwhile, a group of utilities has gained approval for construction of a 137.5 Mmcf/d coal gasification plant in South Dakota. The plant will produce high-Btu pipeline quality gas at approximately $6/mcf. The sulfur content of the coal used in this plant will not be as high as Ohio coal. Although the particular gasification technology being used in this plant will not work on Ohio coal, it will be the country's first commercial size coal gasification plant.

However, the plant's proposed pipeline gas pricing provisions have been challenged in court by a number of groups, including the Ohio Consumers Council. This could set initial production back one year from its intended 1983 start-up date.

There are a number of proposed coal gasification and liquefaction projects being proposed in Ohio and in a number of other coal-producing states. The

tremendously high costs connected with these plants -- in the range of $1 billion per plant -- forces the cost of the end product far above the cost of natural gas or oil from conventional sources.

Three circumstances must take place to narrow the price gap between synthetic fuels from coal and conventional fuels:

First, the price of coal must remain stable. As demand for coal rises, the price will also rise. If the price of gasified coal to Ohio consumers remains comparable with other available fuels, gasification of Ohio coal will attract investment funds. However, as ever-increasing amounts fo coal are required to feed the synthetic fuel plants the price of available coal might be bid up, perhaps to a level making coal-produced gas uncompetitive. Coal gasification plants in operation at the time should continue to operate because regulatory accommodations will allow the necessary rate treatment to depreciate their equipment.

In such circumstances, investment into gasification plants would <u>not</u> necessarily be forthcoming unless technical developments would reduce gasification process costs.

Second, the price of alternative fuels must continue to rise or at least remain high. Should OPEC suddenly drop its crude price, imported oil would again be less expensive than gasified coal. This could happen if, for example, too much of OPEC's market is eroded away through widespread world-wide conservation and fuel substitution. If the price of improted oil skips around, alternately rising above and then dropping below alternate fuel cost, future profitability of synthetic fuel plants may accrue high risk, inducing investors into less risky ventures.

Third, commercial scale plant construction costs must prove to be low enough to make the price of gas produced competitive. Substantial cost overruns in the first demonstration plants could discourage the construction of future plants.

Since gas utilities seem to be among the pioneers in gasification, it is important for regulatory relationships to be worked out thoroughly and early if coal gasification is to succeed. This is doubly important to Ohioans, as coal will provide the cornerstone of Ohio's energy future.

ELECTRICITY

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In the 1979 Status Report, we noted that while future fuel supplies for Ohio electric generation will be adequate, the utilities themselves face continuing financial difficulties. New generating facility costs and construction times continue to increase rapidly. This situation will continue, but if the increase in demand remains at today's lower levels, new construction to replace obsolete equipment and add to capacities can be delayed until construction costs stabilize and costs of capital in the money market returns to historic levels.

How much Ohio electricity demand will increase is the critical issue. Over the past ten years, Ohio consumers demand patterns have been changing. Thus, it is difficult to make estimates of future Ohio consumers' electricity needs. Ten year projections for future Ohio electricity demand have been modified downward from last year's projections. The forecast through 1990 now shows an annual growth rate of about 3 percent, resulting in an overall growth in Chio electricity consumption of 35 percent during this decade. With the previously historical growth rate of about 7 percent (Tables 1-4), Ohio consumer electric demand would have doubled by 1990.

The substantial decrease in demand has come both from greater efficiencies in consumption in the wake of higher prices and a slowdown in the general economy of the state. This decrease in growth of consumer demand provides strong confidence in the sufficiency of Ohio electrical generating capabilities during this ten-year period, as the generating plants to serve consumer needs in the 1980's were planned and financed in the 1970's. However, this same decrease in consumer demand growth which assures adequacy of service in the 1980's lowers utility revenues from levels they had anticipated, posing cash flow problems to meet existing financial commitments and maintain historic rates of return to investors.

In the light of reduced demand forecasts, many utilities have discontinued or delayed construction plans for new generating plants. (See Table 20). These changes in future demand forecasts were a major factor in utility decisions to cancel construction of four nuclear plants that were to have served Ohio customers (Davis-Besse 2 & 3; Beaver Valley 2). These nuclear units would have served customers of Cleveland Electric Illuminating Co., Duquesne Light Co., Ohio Edison Co., Pennsylvania Power Co., and Toledo Edison Co. Undoubtedly these utility actions were also based on concerns about the future nuclear regulatory environment as well as financial and economic factors.

In addition, Cincinnati Gas and Electric has been forced to delay its new Zimmer nuclear plant by one year for retrofits to meet more restrictive Nuclear Regulatory Commission (NRC) construction requirements. Dayton Power & Light and Columbus & Southern Electric Co. are partners in this facility. The Zimmer plant should be ready for fuel loading in the Fall of 1980, if an operating license is provided by the NRC. When licensed, this plant will add to the capacities and reliabilities of the utilities involved.

The principal problem caused by uncertain future loads and construction times is matching future generating capacity to load requirements, both for on-peak and off-peak service. Reduction of peak load will lessen the need for new generation facilities and allow more efficient, baseload generating units to produce a larger share of the total electricity consumed. This would reduce the cost to consumers in the long run.

The federal Public Utilities Regulatory Policy Act of 1978 requires state commissions to hold hearings on peak reduction and other load management methods. Hearings before the Public Utilities Commission of Ohio (PUCO) on load management and control are expected soon. The PUCO has recently given

increased emphasis to utility innovation to reduce peak loads and to improve existing generating plant performance as alternatives to building new generating capacity.

Reduction of sharp peaks to delay if not eliminate the near-term need for new capacities has been explored by means of a peak-load pricing mechanism in the rate structure which calls for rates up to 60 percent lower for electricity used during non-peak generating periods. Also, load management practices such as utility-controlled interruption of electric water heaters during peak generating hours has proven effective in several tests conducted in the state.

These tactics, coupled with the overall reduced demand resulting from increased conservation ethics, can stretch out the time for which new capacities will be necessary without endangering the reserve capacities of Ohio's electric utilities.

As for future reliability of generating fuels, supplies appear to be adequate throughout the 1980's (Table 24). Coal is the major fuel for Ohio electricity generation, accounting for about 95 percent of net generation in 1979. Although the quantity of coal used in Ohio to produce electricity will increase in the forecast period to an estimated 62.6 million tons in 1989 from 51.5 million tons in 1979, the proportion of total Ohio electric generation that is coal fired will decline slightly relative to other fuels. This is due to the almost five-fold increase in nuclear generation capability expected in the next ten years. The shift in fuel base is particularly evidenced by Toledo Edison, which projects a change from 62 percent coal and 26 percent nuclear to 50 percent coal and 45 percent nuclear by the end of the decade. The shift to nuclear generating facilities is even more extensive in surrounding states and these plants will make a critical contribution to their electricity needs in the 1990's.

Oil and natural gas do not provide significant fuel input to power generation in Ohio and are principally used by Ohio utilities for generating unit start-up, flame stabilization and peaking. Supplies of both fuels are forecast to be sufficient (Table 24). However, the potential interruptibility of petroleum supplies and the relative low priority of utility usage during periods of shortage makes it the least reliable Ohio electric generation fuel for the foreseeable future.

While the percentage of oil in the overall Ohio fuel mix will decline in the forecast period, use of oil for Ohio electric generation in winter periods is projected to increase by 16 percent. Given the predominant use of coal by the Ohio utilities, interruption of oil supplies would have less direct effect on Ohio consumers in comparison with consumers in most states.

However, Ohio electrical generation could be vulnerable to either an oil supply interruption or a shut down of nuclear generating facilities. While Ohio utility electrical generation itself would decline minimally from such problems, surrounding states are much more dependent on these sources for generation and would face more substantial reductions in generation. Such reductions could put pressure on Ohio utilities to increase generation to meet these external needs. This could strain Ohio utility reserve capacity.

Greater reliance on coal-burning electrical generation throughout the U.S. would help solve these potential problems. Reducing such vulnerability cannot be done without a clear commitment at the federal level to utilize coal resources.

In many areas of the country alternative sources for electrical generation play a much larger role than they do in Ohio, and the nature of these sources are such that we cannot look forward to significant contributions from these

sources here. Hydroelectric generation, for instance, plays a large role in the mid-South, Northwest, West and to some extent the Northeast. While there is some hydroelectric generation in Ohio now and a small additional amount can be expected to be added, this source will not be able to provide even 1 percent of the state demand.

Geothermal generation is growing in the West and Northwest, but the geology of Ohio does not allow for this type of generation here. The same is true of pumped storage which is now growing in other parts of the country, but our geology cannot accommodate this technology.

The most promising of alternative generation sources in Ohio is to burn solid waste in the major metropolitan areas in small generating plants. The construction and operation of this type plant is much more expensive than a large utility generating plant if examined from an operational point of view. But considering the costs saved by the municipalities in avoiding extensive landfill additions, the cost comes more into line.

Overall, barring serious spill-over problems from surrounding states, there will be sufficient generating capabilities and supplies of fuel for Ohio electric generation throughout the 1980's. To avoid financial problems for Ohio utilities and to mitigate consumer rate hikes, greater emphasis must be placed on increased generating plant productivity and customer load management innovation to further reduce peak demand. Such initiatives will serve to alleviate future costs for both utilities and consumers (See Table 25).

In particular, greater attention should be given to the regulatory rate structures that reward utilities for more efficient generation and customers for more efficient consumption. Further incentives are also needed for utilities to use more Ohio coal for power generation.

Greater federal attention must be paid to large-scale coal combustion. Such efforts would help Ohio utilities to be better able to meet reasonable environmental standards, as well as facilitate market opportunities for export of Ohio produced coal. This would be particularly timely with uncertainties about supplies of other energy sources.

PETROLEUM

PETROLEUM

The international and national nature of the petroleum supply and distribution network ties Ohio's petroleum situation to factors substantially beyond direct control of Ohioans. Ohio does not produce a major portion of its basic crude oil supply as it does coal and natural gas. In fact, the only crude oil that is produced in Ohio is shipped out-of-state and refined into waxes and lubricants. Therefore, the State does not have the capability to enhance its conventional petroleum supplies in the same way it can enhance coal or natural gas supplies.

Furthermore, the federal government has principal responsibility for regulating crude oil and petroleum product prices and allocations. These regulatory powers, along with federal tax policies, shape incentives for exploration and production of new supplies. Thus, Ohio's ability to affect its petroleum situation is constrained by two basic considerations: first, that petroleum supplies for Ohio are imported from other states and other countries; second, that most petroleum problems arise and must be addressed at the national level.

National level petroleum supply problems affecting consumers in Ohio and other states are: 1) a continuing reliance on unreliable expensive foreign oil even though conservation efforts are decreasing American petroleum usage; and 2) declining producible crude oil reserves in the United States. The first problem arises because foreign-source oil is the least reliable energy source available to the United States. Its use leaves the United States vulnerable

in many ways -- vulnerable to supply interruptions, vulnerable to price increases, and vulnerable to the economic instability caused by rapidly changing prices. The second problem only aggravates this. U.S. crude oil reserves declined by 6 percent in 1979. U.S. proven reserves have been declining since 1971. This means that the capability to continue producing oil at current rates is declining and will continue to decline unless exploration adds more to proven reserves than production depletes them. If the U.S. does not reverse the current trend of declining proven reserves, there will be a continued need to import oil.

Substitution of most petroleum supply with more reliable fuel types would be difficult, since our major use of petroleum is in liquid transportation fuels. Substitution with gaseous fuels would be possible, but major modifications to transportation vehicles and the processes for manufacturing them would be needed. Over the long term, the introduction of such innovations as electric-powered vehicles and synthetic fuels could reduce the nation's requirements for refined petroleum products. (See the section on Alternate Fuels for expanded discussion).

For the near term though, addressing petroleum supply problems means producing more oil domestically from conventional and other sources.

Events of the Past Year

The nation's vulnerability to oil supply interruptions was clearly demonstrated during the aftermath of the 1979 Iranian Revolution. Imports from Iran for 1979 fell 350,000 barrels per day (b/d). Eventually, this supply shortfall was made up by increases of 284,000 b/d from Saudi Arabia and 171,000 b/d from Nigeria. However, the perceived unreliability of petroluem supply created feverish activity on the spot market. Prices of

spot crude were bid up to $50 a barrel. This volatile market gave members of the Organization of Petroleum Exporting Countries (OPEC) the opportunity to substantially increase the contract prices of their oil as well. These prices have now risen from an average of $13 per barrel to about $32 per barrel in one and a half years. This translates into a 146 percent increase, significantly beyond the pace of inflation in industrialized countries. In an effort to make firm new OPEC benchmark crude oil prices, Saudi Arabia increased its production by 1 million b/d above self-imposed ceiling levels. The greater amount of available crude has moderated additional price increases by other OPEC members and has lowered the spot market cost of crude from its $50 per barrel high to about $38.

The rate of domestic production in 1980 has increased by almost 3 percent over 1979, chiefly due to expanded Alaskan production. Additional incentives for domestic exploration and production were instituted in the last year, principally in the form of wellhead price decontrol.

Beginning in January, 1980, domestic crude oil subject to price controls was freed from those controls at the rate of 4.6 percent of production per month. This phasing in of uncontrolled higher prices has cushioned the impact of the dramatic increase in world prices of crude oil. By October, 1981 (or sooner, if mandated by the President), crude oil prices in the United States will no longer be subject to price controls and allocations.

Unfettered, this would allow producers to earn higher rates of return on their investments, thus making the risk-taking of exploration more attractive.

While decontrol gradually provides higher incentives for increased production of domestic oil, tax policy can take away much of that incentive. A new federal excise tax on the production of domestic oil went into effect

on March 1, 1980. This Windfall Profits Tax sends to Washington a substantial portion of the additional profits of crude oil production that accrue to oil companies as the world-wide crude oil prices increases.

The new tax has been severely criticized by some oil industry experts as decreasing the potential for domestic oil production by reducing the available capital for direct investment in new crude oil exploration and production. The American Petroleum Institute has estimated that the industry would produce 1.5 million barrels per day more by 1985 if the money going to the tax were to be made available for exploration in new fields.

A combination of rapidly rising prices caused by continuing rounds of OPEC price increases and an awareness of our supply vulnerability brought on by several interruptions has spurred an increased petroleum conservation effort in the past year or two. Through July, 1979, the United States was consuming roughly 18.7 million b/d of petroleum products, while importing about 8.3 million b/d in refined petroleum products and crude oil. During the same period in 1980, the nation has averaged about 17.3 million b/d consumption while importing about 7.2 million b/d.

Dramatic as this consumption reduction is, the nation's vulnerability has not been substantially reduced. A comparison of current imports to imports at the time of the 1973 Organization of Petroleum Exporting Countries' (OPEC) embargo illustrates this fact. Net imports of crude oil and finished products to the U.S. in 1973 were 6.0 million b/d. This was roughly one-third of the national petroleum supply. Today the United States imports roughly 40 percent of its supply, a half million b/d more than it did in 1973, thus our dependency has grown in the face of tenuous supply and rising prices.

For the time being, under federal policies in effect at this writing, the United States - and Ohio - must depend on unreliable petroleum supplies. Moreover, new domestic energy supplies from synthetic sources are unlikely on their own to reduce substantially U.S. dependence on imported oil in this decade. Thus, the vulnerability of the United States will continue during the 1980's unless federal policies are altered to accommodate greater use of coal to supplant oil wherever possible and to encourage greater domestic production.

Ohio Petroleum Outlook

Although Ohio's future petroleum situation will be very much determined by the crossfire of international and national events, significant opportunities do exist to improve Ohio's future petroleum supply reliability. Primarily, the State must embrace more efficient consumer usage of petroleum products and support policies to increase U.S. crude oil production and to develop future substitute petroleum fuels from Ohio resources, such as liquid fuels from coal and gasohol from corn.

Transportation Conservation

Three-fourths of all petroleum coming into Ohio is used eventually for transportation purposes. Other fuels cannot readily be substituted for petroleum in this sector, so most Ohio petroleum fuel users can mitigate price increases or supply shortages only by increasing the fuel efficiency of their travel or by driving fewer miles. Therefore, although there is little that Ohioans can do directly about petroleum supply, prices or availability, improvements in Ohio transportation fuel efficiency must be the cornerstone of Ohio energy conservation efforts.

Ohio consumers have already taken significant conservation measures. Ohio gasoline usage in 1980 is currently almost 10 percent below usage in 1979.

Usage of petroleum inother sectors is expected to be about 4 percent lower than 1979 usage due generally to the economic downturn. As prices increase, transportation usage should fall further. However, continued Ohio petroleum conservation will not result in as much additional usage reduction as already incurred without adverse economic impact. Specific actions to further Ohio petroleum conservation without adverse economic impact are discussed in the Conservation section.

Increasing Domestic Production and Reserves

Despite increased drilling within the United States, there is little expectation that domestic petroleum production in the 1980's can be increased much more than 1.0 million b/d over present daily U.S. production of 8.7 million b/d. On the contrary, there is great concern that domestic production will decline by as much as 2 million b/d in the 1980's under current federal policy. Thus, imports may increase in the 1980's.

Even with the rapid increase in drilling activities of last year (See Table 26), new discoveries are not keeping up with production. Production in the lower 48 states is declining at about 3 to 4 percent per year. The use of enhanced recovery methods stimulated by price decontrol may slow this decline. However, based on current information there is little hope for substantially expanded domestic production in this next decade from historic crude reserves.

The most promising new U.S. petroleum sources underlay federal land in Alaska and offshore coastal areas. Both areas are under federal control for exploration and drilling leases. While estimates of future additions to reserves are speculative as to the amounts, there is general agreement

that total potentially recoverable U.S. crude oil reserves are enormous -- about 140 billion barrels, or roughly equal to all U.S. production in the history of the domestic oil industry. At current U.S. consumption rates, these new reserves could increase our domestic supply five-fold, from 4.5 years supply to 22 years.

Moreover, as the world price of crude increases, greater and greater portions of these potential reserves will become economically feasible to recover. Furthermore, U.S. oil shale resources of up to 400 billion barrels of oil equivalent would add another 60 years of supply at current consumption rates, according to the most recent study compiled by the federal Office of Technology Assessment.

Unfortunately, confirmation of this reserve potential and, therefore, any hope of its production for U.S. consumers, is being prevented by federal land use and off-shore management policy. Leasing of federal lands and off-shore tracts for exploration and drilling recently has been almost non-existent in comparison with other nations.

Initial Department of the Interior (DOI) lease offerings for exploratory drilling are frequently reduced by later DOI withdrawal of substantial tract acreage from bidding. The major focus at this point is on the extent of drilling allowed under the Alaskan Lands Bill, which is currently before Congress. It is absolutely essential to our nation's future energy security to remove these impediments to exploratory drilling on federal lands in order to more fully determine their actual energy resource potential.

Once this is done, the American people can carefully weigh the pros and cons of how or if to produce these resources for their energy needs. It is

really a cruel hoax to deceive the American people, who are the real owners of these "public energy resources," that very little of the huge potential domestic oil and gas resources are being proved and that the only other alternative to expensive foreign imports is economic sacrifice in their own lives. Experts agree that the reserves are there, but this cannot be proved without drilling, and current federal policy prevents this drilling, which results in extended and increased dependence on foreign oil.

Therefore, the critical urgency of allowing exploratory drilling on federal lands cannot be overstressed. Accelerated exploratory drilling and development of new domestic petroleum reserves is perhaps the most urgent of all domestic energy options. At current rates of domestic production, existing proven U.S. petroleum reserves will only last 9 years. Until and unless these federal areas are opened to exploratory drilling, the future for new U.S. domestic petroleum production will continue to be bleak.

Ohio must continue to support prudent development of such potential domestic crude oil reserves and oil shale reserves to offset production decline from conventional sources, while the nation currently moves ahead with enhanced recovery activities and synthetic fuels development.

CONSERVATION

CONSERVATION

"Energy Conservation" has been and will continue to be a top priority nationwide. Unfortunately, the Federal Government to date has not established a clear, consistent energy conservation policy. Neither has it developed effective coordinated program efforts to effect conservation. ODOE believes that for Ohioans to make the most efficient use of Ohio's available energy resources, a clear understanding of "Energy Conservation" should be the basis for their actions.

Conservation should continue to be a high priority to Ohioans because it:

1. Reduces reliance on remote sources of petroleum and other insecure expensive sources of energy from outside the state and the nation;
2. Relieves upward pressures on energy prices and is therefore beneficial to consumers. In 1980, Ohioans will spend $12 billion on energy compared to $10 billion in 1979. Five percent overall conservation by Ohioans, an easily achievable goal, will result in $600 million savings to Ohio consumers;
3. Saves the capital investment funds of energy suppliers and consumers which can be redirected into other more productive job-creating ventures. Some of these funds can be routed into expanded energy research and development of renewable Ohio energy supplies;
4. Reduces need for growth in energy supplies from traditional sources, thereby providing additional time for development of new Ohio energy sources.

The previous sections documented the urgent need for emphasis on transportation fuels. Among all fuels, petroleum products are the most insecure, the least substitutable with alternate fuels, and the most rapidly increasing in price. However, conservation of all non-renewable fuels is imperative. While major emphasis must be placed on petroleum fuel usage efficiency, there must continue to be an Ohio program to increase the efficiency in the use of all forms of energy.

Energy conservation in Ohio should first be seen as a means to an end, not an end in itself. It should enhance and complement, rather than distort, present and future Ohio economic activities. Energy conservation in Ohio should incorporate both: 1) using the least amount of energy needed to support activities essential to the current standard of living. That is, the efficient use of energy to produce goods and services at the lowest possible cost; and 2) matching these support activities with the most appropriate energy form. That is, high grade, scarce, and expensive fuels ought not to be used for applications where lower-grade, more-abundant, cheaper fuels can do the same job. Conservation in this sense preserves higher value energy sources for future use.

ODOE's understanding of "energy conservation" does <u>not</u> incorporate the notion of a sacrifice of the Ohio quality of life to reduce energy consumption. Frequently, this notion of "sacrifice" has been propounded by federal energy policy makers with respect to reducing foreign petroleum imports. In the final analysis, foreign imports will <u>not</u> be substantially reduced until the federal government permits accelerated development of domestic energy supply sources.

As discussed in the preceding sections, significant steps toward this end have been taken in the Energy Security Act through encouraging synthetic

fuels development. However, major federal constraints will remain to developing the great resources of oil, gas, and coal underlying federal lands, and in the siting and operation of coal burning facilities. It is important to note that strong conservation efforts are absolutely essential during this interim period while such new domestic energy supply sources are developed.

Current Conservation Needs

Unfortunately, a second fundamental misconception underlies the federal approach to energy conservation. Federal program initiatives continue to suppose that in the six years since the OPEC embargo, which have included two gasoline shortages, two natural gas curtailments, two coal strikes, and one fuel oil shortage, individual energy consumers must still be reminded of the need to conserve energy and how it should be accomplished.

Current data show two causes for the overall increase in energy use efficiency over the last several years: higher energy prices and increased consumer awareness of the energy efficiency potential of modifying his current usage practices. The effects of these two factors cannot be separated, since both must be present for conservation to occur. Neither seems to be sufficient in itself to induce substantial, permanent behavioral changes which result in real conservation. Higher prices, in the absence of awareness of energy saving methods, only elicit a one-time, short-term energy use reduction, as was evident in lower 1974 gasoline consumption levels immediately after the 1973-74 oil embargo.

Recent events show that energy consumers now understand their own energy interests and make an effort to increase their energy use efficiency. For example according to a recent American Gas Association (AGA) study, residential consumers have already widely undertaken the simplest kinds of "quick fix" home energy conservation measures. These widely adopted

residential conservation measures include lower-in-winter/higher-in-summer thermostat settings, weatherstripping, caulking, and turning out lights.

Starting in 1977, residential consumers began adopting more difficult energy savings methods: increased insulation, storm doors and windows, more efficient space conditioning systems and appliances, and installation of passive and active solar systems. The effect of such implementation is apparent. In 1978, for example, residential natural gas customers used 14 percent less natural gas than they did in 1972.

Current consumer energy conservation needs, therefore, center on receiving information, and in some cases direct technical and/or financial assistance, on how to select and to install the conservation techniques most appropriate to their type of fuel and usage. It will no longer be necessary for government or anyone else to beat a patriotic (but empty) oil drum encouraging consumers to conserve.

Ohio Energy Conservation in 1980

Residential users: Surveys conducted in Ohio by the Ohio State University Research Foundation for ODOE indicate that the trend toward greater consumption efficiencies is continuing. Caulking and weather-stripping are often repeated at 2-3 year intervals. Well over one-half of Ohio households have employed at least one energy conservation measure within the past two years.

Commercial users: The same surveys indicate most businesses have been conserving as well. Most commercial operators have cut back on lighting and heating load. Many have also insulated their buildings and turned off idle machinery. The growing market for building and process energy management control systems also indicates that many commercial and industrial firms are investing heavily in energy utilization efficiency. Business users clearly view such investments as providing an attractive economic return.

Industrial users: Ohio industry has also done much to improve process efficiency. The decline in number of Btu's used per dollar of Gross State Product (GSP) measured in constant dollars is indicative of this. As seen in Table 28, this ratio has dropped from 2.43MMBtu per $100 GSP in 1974 to 1.93 in 1978. Another measure of Ohio industry's desire to improve efficiency is the number of applications for tax exemption under ORC 4915. This law provides exemption from state tangible personal property tax for investments which improve energy efficiency or involve capital investment necessary to support a switch from gas or oil usage to coal. In the first six months of 1980, 49 applications were received, equaling the total number received during all of 1979.

Transportation users: The most dramatic conservation achieved in 1979-1980 occurred in the transportation sector. In Ohio, gasoline consumption in the first half of 1980 was 11 percent below 1979 levels. It is clear that there is a broad-based, conscious effort on the part of all Ohioans to consume less gasoline. This is due to a combination of better vehicle maintenance, more fuel efficient automobiles which comprise an increasing percentage of Ohio vehicles, and people simply driving less by using carpools, trip planning, etc.

State park attendance figures indicate Ohioans are staying closer to home instead of driving long distances for vacations. These trends are expected to continue as new cars will be even more fuel efficient, while fuel prices will continue to increase.

Thus, Ohio energy users have become aware of the conservation methods most suited to their needs and are increasingly applying them.

Ohio's Conservation Outlook

Ohio energy use in the next five years is projected to increase at less than 1 percent per year overall, compared to an historic rate of 3-4 percent per year. Whether as a result of energy prices, conservation information programs, or other factors, the unprecedented sophistication of Ohio energy consumers must now be appreciated in public conservation programs.

The primary thrust of ODOE's State Energy Conservation Plan (SECP) is to provide individual users in each of Ohio's consuming sectors "how to do it" information specific to the conservation techniques most appropriate to their needs. ODOE will continue a comprehensive public education program to inform Ohio consumers that technical assistance is available in selecting and installing conservation measures.

The details of the Ohio Residential Conservation Service (RCS), the Ohio Energy Extension Service (EES), and other state sponsored conservation programs tailored to specific Ohio energy users, such as schools, hospitals, farmers and small businesses, are described in ODOE's Annual Ohio Energy Conservation Report which was submitted to Governor Rhodes and the General Assembly on May 1, 1980.

A most immediate concern facing Ohio energy consumers is the future adequacy of petroleum supplies. Federal rules and regulations preempt direct control of petroleum allocations by states, making Ohio completely dependent upon federal regulations for its supplies. Since Ohio's petroleum supplies are predominantly used for transportation purposes, minor national shortfalls in the availability of petroleum products, such as occurred in the summer of 1979, primarily impact Ohio's transportation users.

Consequently, a major emphasis of Ohio energy conservation efforts must be to help Ohio motorists cope with higher prices and potentially lower supplies without imposing excessive changes in their lifestyles.

The state can play a most important role in assisting Ohio consumers conserve petroleum in their transportation usage. The Petroleum Section of this report brought out the following facts:

1. Petroleum products are the least reliable of all Ohio's energy supplies;
2. Petroleum fuel prices will be the most rapidly rising of all fuels;
3. 98 percent of all Ohio transportation depends on petroleum fuels;
4. Ohio transportation users have no substitute fuels for petroleum.

For these reasons using less petroleum fuel to achieve the same purpose, product, or job effort is essential for continued economic stability in Ohio. Employee commuter usage of petroleum may offer the best opportunity for such increased efficiencies because:

1. Commuter usage represents one-quarter of Ohio's transportation petroleum usage;
2. Unlike most other uses of energy, travel modes to and from work can be modified easily, using less energy.
3. Commuting travel mode modifications serve the same purpose and save money for employees. Generally, it costs less to use fuel-efficient means of getting to and from work.

Substantial increases in Ohio commuters' fuel use efficiency can be achieved through well organized extensive carpooling, vanpooling, and other ride sharing programs, as well as through increased public transit ridership. As there are few current incentives for initiating such activities, ODOE believes it important for the state to provide assistance to commuters and their employers for instituting such commuter programs.

ALTERNATIVE SOURCES

ALTERNATIVE SOURCES

Public attention has increasingly focused on new "renewable" energy sources as alternatives to reliance on traditional forms of coal, oil and natural gas. Although great long term potential exists for these sources to provide for Ohio's future needs, such alternative sources collectively will not contribute significantly to Ohio's energy supply in the next five years, and may only slowly gain a larger niche through the end of the century. However, several specific fuel source alternatives hold great promise in the near term.

Alcohol from Corn and Crop Wastes

Alcohol holds the most promise as an Ohio renewable energy resource in the near term, particularly as an extender of, or substitute for, transportation fuels. There is already a high level of experience and familiarity with alcohol fuel production in the nation. The technology to produce alcohol fuels from non-petroleum sources already exists. Costs of producing alcohol fuels derived from corn and other agricultural products can be further reduced so that alcohol can be price-competitive with gasoline in the future.

Principal constraints on alcohol fuel production will arise from limits of grain production and from uncertainties about markets for alcohol. It currently takes 2.4 bushels of corn to produce a gallon of alcohol. If alcohol is to constitute a significant share of energy use, substantial grain production must be available, although removal of alcohol from the grain does not reduce its protein content or its value as animal feed. In terms of market support, the commitment to alcohol development from the Energy Security Act of

1980 may be sufficient to spur production.

Interest in alcohol production has grown considerably in the past year reflecting higher levels of public awareness and increased cost competitiveness with gasoline, rather than any technical development. Provision of tax incentives by removing federal taxes on alcohol has helped make alcohol fuels more competitive with petroleum based fuels.

Alcohol is being used in a 1 to 9 mixture with gasoline as "gasohol." Further increase in the proportion of alcohol would necessitate modifications in motor fuel-burning systems making marketing even more difficult. Receptivity of the use of gasohol is reflected in the growing number of Ohio retail outlets selling gasohol.

Recently, the U.S. Department of Energy issued a $25 million grant for a commercial-sized alcohol plant to be owned jointly by Ashland Oil Co. and the Publicker Industries, Inc. The plant, to be operational in 1982, will produce about 60 million gallons of alcohol per year (or 3900 b/d oil equivalent).

Governor Rhodes' Ohio Task Force on Alcohol Fuel has recommended the rapid development of Ohio plants to produce anhydrous ethanol (ethyl alcohol), chiefly for agricultural use. As a result, the Farm Bureau Development Corporation, the Ohio Department of Agriculture, and ODOE entered into joint sponsorship of a 260,000 gallon per year plant in Mt. Sterling, Madison county. The plant should begin full production in January, 1981.

The Governor's Task Force also recommended the creation of an Ohio Alcohol Fuels Advisory Council. Subsequently, the Council was established by the General Assembly (Am. H.B. No. 602) to study the development and use of alcohol fuels in Ohio and the feasibility of using Ohio agricultural commodities as a feedstock for such fuels. The Council is composed of

representatives of the Department of Energy, Department of Agriculture, the Environmental Protection Agency, and the Water Development Authority, two members from each House of the General Assembly, and five public members appointed by the Governor to represent professional chemical engineers, independent gasoline retailers, and agricultural, consumer, and transportation interests. The Advisory Council will report its findings and recommendations for the legislative or administrative actions to the Governor and General Assembly by July 1, 1981.

Ohio's overall development plan for ethanol production includes six large commercial plants (50 million gallons/year), 30 regional plants (5 million gallons/year) and 100 smaller on-the-farm plants (500,000 gallons/year). The large commercial plants will operate independently, purchasing and processing their grain feedstock, selling their alcohol product (and byproducts such as distiller's grains, CO_2, and oils) without being dependent on areawide feedstock suppliers or sales to local customers. The regional 5 million gallon plants will depend on the local areas as a market for part of their alcohol and as a market for a large part of their distillers grains, especially in the wet form. The small, on-the-farm size plants will produce a lower proof alcohol with some water present. This alcohol can be used as a straight fuel (not mixed with gasoline) on the farm, but must go through further operations to be raised to a 199+ proof anhydrous state before being sold for mixing with gasoline.

This additional operation would be expensive for the small scale operation. However, individual farmers could make cooperative arrangements with one of the large commercial plants to either purchase the low proof alcohol or with each other to form a cooperative alcohol distillation and sales company. Such cooperative support could lead to more profitable operation of both the regional and on-the-farm plants.

Ohio is by no means alone in its pursuit of alcohol fuels. Demonstration plants of commercial size are planned across the nation. Interest is particularly strong in the Midwestern corn producing states. This interest was sharpened when the President imposed grain embargoes on Iran and the Soviet Union in late 1979, which reduced market demand for grains. Consequently, grain producers have begun to look for new markets for their products.

This growing acceptance and development of alcohol fuels can be compared with the level of production and market experience in other non-conventional fuels' development. No large-scale operations for conversion of coal or shale to liquid or gaseous form are located in the United States, whereas alcohol is produced continuously and in large volumes. Consequently, the use of alcohol as a supplement to or as a substitute for petroleum appears to have a bright future.

Solar Power

Solar power offers another promising alternate energy source. Ohio does not generally have enough sunlight year around to make active solar systems economically feasible for total user dependence under the current state-of-the art. Therefore, current emphasis is being directed to passive residential solar systems for reducing space heating and lighting loads and to active solar water heating systems in the residential, commercial, and industrial sectors.

USDOE has concentrated its longer term research efforts on development of photovoltaic generation of electricity directly from sunlight. Amorphous semiconducting materials show promise as materials for future use in photovoltaic cells that can be produced much more cheaply than the current silicon crystals used. A photovoltaic cell made from silicon is presently grown from a single crystal--a slow, expensive process. Now, the cheapest cost for photovoltaic production of electricity is about 70¢ per kwh. USDOE estimates photovoltaic

cells must be able to produce electricity for 7¢ per kwh to become competitive with conventional electric generation technologies. This goal may be attainable within the next several years.

Electric Storage Systems

For any advanced form of electricity generation (e.g., photovoltaics) and/or for a substantial portion of new transportation vehicles to be electric powered, it is essential to develop adequate and reliable electric storage systems. A particularly hopeful development was the recent perfection by General Motors of a new zinc-nickel-oxide battery. The battery is to be used in GM's electric car before it will be commercially available in the mid-1980's. GM says that chassis and body design must now be accommodated to the electric car before it is ready for commercial use.

Gulf & Western Industries is developing a zinc-chloride battery that has potential for even greater storage capacity, longer life, and lower depletion of power than the GM battery system. General Motors will soon test the G & W batteries in a van with a view to using them under a G & W license. Electric vehicles will soon be appealing for short-range transportation in high-density areas.

Energy storage developments may have wider use than in electric cars. Solar and wind systems currently need back-up heating or electric generating systems to provide energy during periods when the sun is not shining or wind blowing. Storage systems could provide the needed auxiliary power.

Municipal Wastes Generating Steam, Electricity and Gas

Use of refuse for generation of steam or electricity has substantial potential nationally and in Ohio. Municipalities in Ohio are giving increasing attention to developing refuse burning plants for steam generation.

In September, 1980, Akron's plant should be at full capacity, burning 1,000 tons of solid waste daily to produce 350,000 lbs. of steam per hour. The City of Columbus trash burning power plant (90MW) is also progressing through construction and is scheduled to begin generation of electricity in 1982. Refuse burning systems, such as the ones in Akron and Columbus, offer fuller recovery of the energy value of what would otherwise end up in land fill, as well as reducing the need for new land fill sites. Akron expects to reduce its land fill tonnage by 65% per week under full operation.

In terms of methane, municipal sewage plants have the potential to produce significant amounts of methane gas to use as a fuel to burn or dewater their sludge, thereby reducing their need for expensive petroleum fuels and natural gas.

Wind Power

Wind power systems contribute a miniscule amount of energy on a national basis but have potential for increase. A number of sites are promising, but research and development is focusing on small-scale generation. Very little has happened in the development of wind systems throughout Ohio. In general wind systems cannot make a large commercial contribution in this state because of the lack of consistent high wind speeds. However, wind patterns in many areas along the coast of Lake Erie may be suitable for generating electricity. Over the past year, though, no progress has been made in locating an operating unit along the Lake. A test site at Sandusky, Ohio sponsored by the National Aeronautics and Space Administration Lewis Research Center is functioning with maximum generation of 100 KW at 18-34 miles per hour wind speed.

Developing Ohio Alternative Sources

Government has taken on the task of supporting research and development of technologies for tapping and using alternative sources of energy. Both

federal and state governments have decided this is necessary. The outlook for developing alternative sources received a substantial boost this year from passage of the Energy Security Act of 1980. The principal funding from the Act will be used to support a wide variety of synthetic fuel production from coal and oil shale sources. The new Synthetic Fuel Corporation will have at least $20 billion to support a wide variety of synthetic fuel research and development projects. Furthermore, the Act authorizes $1.2 billion to promote production of alcohol and other fuels from biomass, including crops and crop residues, timber and timber wastes, and animal waste. Financial assistance is also authorized for expansion of municipal waste programs, wind and geothermal programs, and for the establishment of a solar and energy conservation bank. Of these programs, Ohio is best situated for expansion of synthetic fuels from coal, alcohol production and municipal waste generation.

The state should examine the incentives and supports needed to encourage specific synfuels development based on these Ohio resources. Priority emphasis will be placed on the synfuel technology projects that can convert an Ohio energy resource into a fuel for Ohio consumers which will replace or supplement costly imported fuels.

The concept set forth in last year's Status Report for development of other technologies that use alternate sources still appears valid. The Report said that innovation needs support from government, but that private developers are better able to determine which technological paths bear the most potential for commercial success. Thus, the state should aid development of those technologies supported by private developers.

Currently, very few technologies related to new or renewable energy are good candidates for general adoption by Ohio consumers. Most technologies still cost too much to compete with their more conventional counterparts. This suggests that their development still lies in the realm of research and that they are not yet ready to move into the commercial market. For those that are ready for commercial use, the rate of market diffusion and consumer adoption of new technologies that are cost competitive depends on a number of important factors:

Commercial risk of new technology. Commercial risks may arise from uncertainty about demand for a new product or process, particularly if no alternative for the product exists, and consumer desires have never before been explicit. Commercial risk may also stem from uncertainty about competitors' ability to produce a similar or better product.

The Ease of manufacture. Existing industry will be most likely to manufacture a new product if there is no need to retool production equipment, replace auxiliary equipment, or change production over completely.

Size of capital investment. If new technology involves extensive capital investment, users will wait until current capital stock is fully depreciated or until they must replace equipment or processes. If new technology requires enormous sums to build even one plant, the potential investors may shy away from such high risks. The degree of capital investment makes alternative sources particularly costly when compared to conventional sources where exploration costs can be deducted in full each year.

Psychological factors. A new idea will not gain broad acceptance if potential users do not believe there is a need for the product, i.e., if they believe they can do without it. Neither will it gain acceptance if potential users are not aware it exists. In some cases, public prejudice against a new concept may also serve as a barrier.

One technology that does meet the competitive cost criterion and seems ready for Ohio commercialization is the ground water source heat pump. This technology has been found to be one of the most economical heating and cooling systems that can be used in Ohio. Its only drawbacks appear to be a relatively high commercial risk caused by a low level of public recognition. A subdivision of homes having these systems is now being built north of Columbus. Successful commercial demonstration in this subdivision and public recognition of this fact could begin to build consumer demand for this technology. It will be relatively easy to increase the supply of these devices since the manufacturing and marketing arms of the conventional heat pump industry are already well established here in Ohio.

An important role for the state in alternative technology development is to help publicize its availability and proven efficiency to energy consumers for whom it is a viable alternative. As R & D brings new technologies to the point where they are cost-competitive for broad groups of users, the state may find it appropriate to assist in building either supply or demand for the innovation if the process of diffusion in the private sector appears to need quickening.

TABLES

Table 1 Ohio Energy Consumption by Fuel, Residential Sector

	1973		1974		1975		1976		1977		1978		1979	
	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu
Distillate/Kerosene (MM Bbls)	13.97	80.83	13.37	77.37	13.79	79.83	17.70	102.42	17.67	102.25	17.36	100.49	16.64 (e)	96.35 (e)
% of Total		12.2%		11.8%		12.3%		14.9%		15.7%		15.1%		14.6%
LPG (MM Bbls)	5.07	20.32	4.98	19.98	5.16	20.71	5.31	21.29	5.00	20.05	4.87	19.54	4.67 (e)	18.73 (e)
% of Total		3.1%		3.0%		3.2%		3.1%		3.1%		2.9%		2.8%
Petroleum Total	19.04	101.15	18.35	97.35	18.95	100.54	23.01	123.71	22.67	122.30	22.21	120.03	21.31 (e)	115.08 (e)
% of Total		15.3%		14.8%		15.5%		18.0%		18.7%		18.1%		17.5%
Coal (Million Tons)	0.72	19.13	0.76	18.76	0.50	12.21	0.46	11.21	0.40	9.74	0.26	6.19	0.29	6.81
% of Total		2.9%		2.9%		1.9%		1.6%		1.5%		0.9%		1.0%
Natural Gas (Billion c.f.)	439.21	453.27	435.80	449.25	427.82	441.51	440.19	454.20	401.93	414.79	416.72	430.06	406.29	419.30
% of Total		68.4%		68.5%		67.9%		66.0%		63.5%		64.7%		63.7%
Electric (Billion kWh)	26.03	88.81	26.72	91.17	28.02	95.60	28.95	98.78	31.03	105.87	31.75	108.33	34.34	117.16
% of Total		13.4%		13.9%		14.7%		14.4%		16.2%		16.3%		17.8%
Total	-----	662.36	-----	657.03	-----	649.06	-----	687.90	-----	652.7	-----	664.61	-----	658.35 (e)

Note: Estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy and the Federal Energy Data Systems (FEDS).

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Table 2 Ohio Energy Consumption by Fuel, Commercial Sector

	1973		1974		1975		1976		1977		1978		1979	
	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu
Jet Fuel (MM Bbls) % of Total	11.31	75.03 18.7%	9.26	61.45 16.0%	9.03	59.90 16.0%	8.13	53.94 13.8%	10.15	67.32 16.8%	10.85	71.99 18.0%	10.40 (e)	69.02 (e) 16.5%
Distillate (MM Bbls) % of Total	4.84	28.19 7.0%	4.71	27.44 7.1%	4.98	29.01 7.8%	6.23	36.29 9.3%	6.29	36.12 9.6%	6.29	36.64 9.2%	6.03 (e)	35.13 (e) 8.4%
Gasoline (MM Bbls) % of Total	.83	4.30 1.1%	.83	4.34 1.1%	1.13	5.95 1.6%	1.07	5.61 1.4%	.91	4.77 1.3%	.93	4.88 1.2%	.89 (e)	4.66 (e) 1.1%
LPG (MM Bbls) % of Total	.56	2.26 0.6%	.55	2.22 0.6%	.57	2.30 0.6%	.59	2.37 0.6%	.56	2.23 0.6%	.54	2.17 0.5%	.52 (e)	2.08 (e) 0.5%
Residual (MM Bbls) % of Total	.69	4.34 1.1%	1.23	7.73 2.0%	3.06	19.24 5.1%	3.45	21.69 5.6%	3.61	22.70 6.1%	3.36	21.12 5.3%	3.22 (e)	20.25 (e) 4.8%
Petroleum Total % of Total	18.23	114.20 28.5%	16.58	103.19 26.8%	18.77	116.40 31.1%	19.47	119.90 30.7%	21.43	133.14 35.5%	21.97	136.8 34.2%	21.06 (e)	131.16 (e) 31.3%
Coal (Million Tons) % of Total	.39	10.41 2.6%	.41	10.18 2.6%	.27	6.63 1.8%	.25	6.08 1.6%	.22	5.30 1.4%	.14	3.36 0.8%	.15 (e)	3.72 (e) 0.9%
Natural Gas (Billion c.f.) % of Total	196.66	202.96 50.7%	192.50	198.66 51.6%	169.36	174.78 46.7%	179.39	185.13 47.4%	149.81	153.78 41.0%	172.43	177.95 44.5%	189.73	195.80 46.7%
Electric (Billion kWh) % of Total	21.36	72.88 18.2%	21.39	72.98 19.0%	22.38	76.36 20.4%	23.10	78.82 20.2%	24.24	82.71 22.1%	24.08	82.16 20.5%	26.04	88.86 21.2%
Total	-----	400.45	-----	385.81	-----	374.17	-----	389.93	-----	374.93	-----	400.29	-----	419.54 (e)

Note: Estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy and the Federal Data Systems (FEDS).

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Table 3 Ohio Energy Consumption by Fuel, Industrial Sector

	1973		1974		1975		1976		1977		1978		1979	
	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu
Diesel Fuel (MM Bbls)	2.34	13.63	1.68	9.79	2.04	11.88	2.80	16.31	2.29	13.34	2.54	14.80	2.44 (e)	14.19 (e)
% of total		0.9%		0.7%		0.9%		1.2%		1.0%		1.1%		1.0%
Distillate (MM Bbls)	4.64	27.03	6.24	36.35	5.89	34.31	7.48	43.57	9.39	54.70	8.51	49.57	8.16 (e)	47.52 (e)
% of total		1.8%		2.4%		2.7%		3.2%		4.1%		3.8%		3.4%
Gasoline (MM Bbls)	1.46	7.64	1.55	8.11	1.35	7.08	1.22	6.40	1.02	5.88	1.03	5.42	.99 (e)	5.20 (e)
% of total		0.5%		0.5%		0.5%		0.5%		0.4%		0.4%		0.4%
LPG (MM Bbls)	1.69	6.78	1.80	7.22	1.63	6.55	1.87	7.50	2.28	9.16	3.25	13.05	3.17 (e)	12.51 (e)
% of total		0.5%		0.5%		0.5%		0.6%		0.7%		1.0%		0.9%
Residual (MM Bbls)	4.55	28.61	4.32	27.16	5.67	35.65	6.41	40.30	8.52	53.57	7.50	47.15	7.19 (e)	45.21 (e)
% of total		1.9%		1.8%		2.8%		3.0%		4.0%		3.6%		3.3%
Other Petro. Products (MM Bbls)	27.53	170.03	21.97	124.78	20.39	115.60	20.80	129.59	23.83	135.38	24.64	139.79	23.67 (e)	134.81 (e)
% of total		6.7%		8.4%		9.0%		9.5%		10.1%		10.7%		9.7%
Petroleum total	37.21	211.72	37.56	213.41	36.97	211.07	40.58	243.67	47.43	272.83	47.47	269.76	45.51 (e)	258.44 (e)
% of total		14.3%		14.4%		16.3%		17.9%		20.3%		20.6%		18.8%
Coal (Million Tons)	27.78	611.64	24.36	622.57	20.88	542.25	20.16	522.43	21.21	548.36	18.73	484.39	20.60	532.66
% of total		41.4%		42.6%		41.9%		38.5%		41.0%		36.9%		38.6%
Natural Gas (Billion c.f.)	439.59	453.45	427.65	441.33	344.54	355.56	373.43	385.38	285.13	294.25	320.38	330.89	340.35	351.24
% of total		30.7%		29.7%		27.5%		28.4%		22.0%		25.0%		25.5%
Electric (Billion kWh)	59.05	201.48	57.56	196.40	54.07	184.49	60.71	207.14	65.38	223.08	64.02	218.44	69.24	236.25
% of total		13.6%		13.2%		14.3%		15.2%		16.7%		16.3%		17.1%
Total	-----	1,478.29	-----	1,483.71	-----	1,299.37	-----	1,358.62	-----	1,337.32	-----	1,311.48	-----	1,378.79

Note: Other petroleum products include kerosene, coking coal used as a fuel, and petrochemical feedstocks.
Estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy, and the Federal Energy Data System (FEDS).

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Table 4 Ohio Energy Consumption by Fuel, Transportation Sector

	1973		1974		1975		1976		1977		1978		1979	
	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu	Physical Units	Trillion Btu
Distillate/Diesel (MM Bbls)	17.21	100.25	14.91	86.85	15.26	88.89	17.96	104.62	17.00	99.26	19.45	113.3	18.65 (e)	108.63 (e)
% of Total		13.9%		11.8%		11.9%		13.3%		12.3%		13.7%		13.7%
Gasoline (MM Bbls)	119.43	626.77	114.99	603.45	116.96	613.77	121.37	636.96	125.73	659.81	127.29	667.90	122.04 (e)	640.44 (e)
% of Total		86.6%		82.2%		82.0%		80.9%		81.9%		80.8%		80.8%
Jet Fuel (MM Bbls)	6.66	36.30	5.65	31.10	5.95	32.30	5.66	31.20	6.06	33.48	5.62	31.24	5.39 (e)	29.95 (e)
% of Total		4.7%		4.2%		4.3%		4.0%		4.2%		3.8%		3.8%
LPG (MM Bbls)	.09	.35	.09	.35	.07	.28	.08	.32	.09	.34	.08	.31	.08 (e)	.30 (e)
% of Total		0		0		0		0		0		0		0
Residual (MM Bbls)	.10	.63	.33	2.07	.61	3.81	.93	5.85	.64	4.02	.65	4.09	.62 (e)	3.92 (e)
% of Total		0.1%		0.3%		0.5%		0.7%		0.5%		0.5%		0.5%
Petroleum - Total	143.49	764.70	135.97	723.82	138.85	739.08	146.0	779.03	149.56	796.91	153.09	816.92	146.78 (e)	783.24 (e)
% of Total		98.3%		98.6%		98.7%		99.0%		99.0%		98.9%		98.8%
Natural Gas (Billion c.f.)	12.00	13.21	10.02	10.34	9.03	9.31	7.72	7.97	8.06	8.31	8.92	9.21	9.06	9.35
% of Total		1.7%		1.4%		1.2%		1.0%		1.0%		1.1%		1.2%
Electric (Billion kWh)	.04	.14	.04	.14	.04	.14	.04	.14	.04	.14	.05	.17	.05	.18
% of Total		0		0		0		0		0		0		0
Total	-----	778.05	-----	734.3	-----	749.53	-----	787.14	-----	805.36	-----	826.3	-----	792.77 (e)

Note: Estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy and the Federal Energy Data System (FEDS).

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Table 5 Ohio Gross Energy Consumption by Sector, 1970-1979
(Trillions of Btu's)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Residential	685.4	676.0	697.1	662.4	657.0	649.9	688.0	652.7	664.6	658.4 (e)
% of Total	18.0	18.2	17.6	16.8	16.8	16.9	17.4	16.6	17.0	16.3
Commercial	368.3	365.8	396.4	400.4	385.0	374.2	389.9	374.9	400.3	419.5 (e)
% of Total	9.7	9.8	10.0	10.2	9.8	9.8	9.8	9.5	10.2	10.4
Industrial	1507.0	1402.9	1470.4	1478.3	1483.7	1293.4	1358.6	1337.7	1311.5	1378.8 (e)
% of Total	39.6	37.8	37.1	37.6	37.9	33.7	34.3	34.0	33.5	34.2
Transportation	667.4	684.9	743.3	778.0	734.3	748.5	787.1	805.4	826.3	792.8 (e)
% of Total	17.5	18.4	18.7	19.8	18.8	19.5	19.9	20.5	21.1	19.7
Energy for Net Generation Utilities	577.7	585.1	660.3	616.0	654.7	771.5	737.0	760.7	708.6	782.0 (e)
% of Total	15.2	15.8	16.6	15.7	16.7	20.1	18.6	19.3	18.1	19.4
Total Consumption	3805.8	3714.7	3967.5	3935.1	3914.7	3837.5	3960.6	3931.4	3911.3	4031.5 (e)

Note: Energy for net generation is equal to the difference between total consumption of energy by the electric utilities sector and the Btu equivalent of the electricity generated. All estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy, and the Federal Energy Data Systems (FEDS)

Table 6 Ohio Gross Energy Consumption by Fuel, 1970-1979

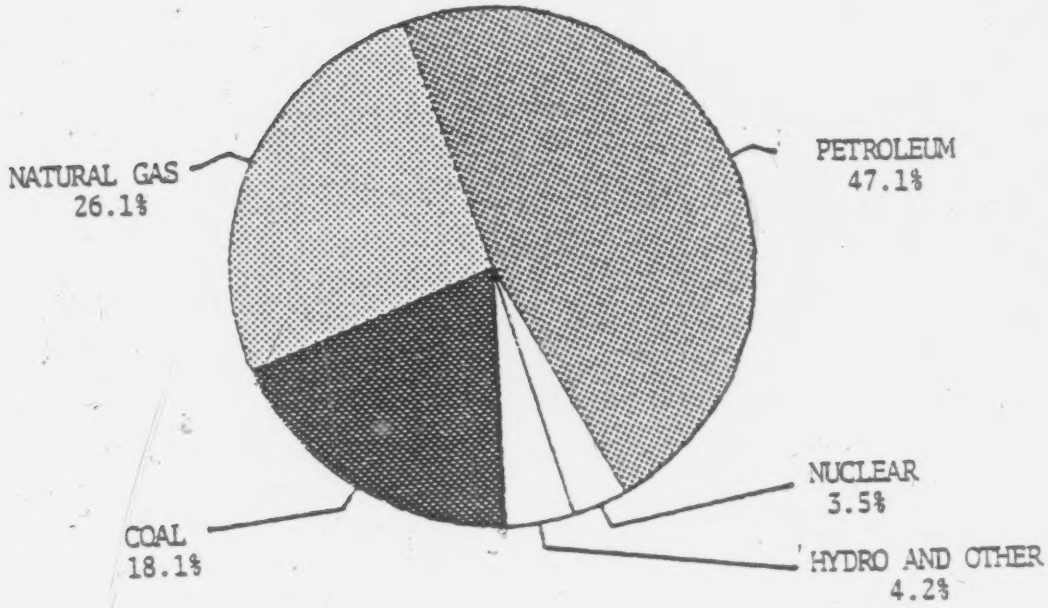
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Coal										
Million Short Tons	67.60	63.30	67.91	65.66	69.72	68.08	71.02	74.19	67.96	72.75
Trillion Btu	1,642.72	1,511.70	1,620.31	1,581.89	1,620.76	1,659.01	1,632.45	1,691.52	1,543.45	1,697.26
% of Total	43.2%	40.7%	40.8%	40.2%	41.4%	43.2%	41.2%	43.0%	39.5%	42.1%
Petroleum										
Million Barrels	202.20	203.07	218.39	227.98	220.23	223.70	242.32	255.62	260.34	249.60
Trillion Btu	1,076.40	1,081.03	1,162.55	1,213.65	1,172.39	1,190.84	1,289.94	1,360.74	1,385.87	1,328.74 (e)
% of Total	28.3%	29.1%	29.3%	30.8%	29.9%	31.0%	32.6%	34.6%	35.4%	33.0%
Natural Gas										
Billion Cu. Ft.	1,052.93	1,087.13	1,147.80	1,104.16	1,086.65	956.88	1,005.93	847.50	929.59	945.43
Trillion Btu	1,086.63	1,121.91	1,184.53	1,139.49	1,121.42	987.49	1,038.12	874.62	959.38	975.69
% of Total	28.5%	30.2%	29.9%	29.0%	28.6%	25.7%	26.2%	22.2%	24.5%	24.2%
Nuclear and Hydro										
Billion kWh	.01	.01	.01	.01	.01	.01	.01	.47	2.43	2.84
Trillion Btu	.10	.10	.10	.09	.10	.10	.10	4.57	22.65	29.76 (e)
% of Total	0	0	0	0	0	0	0	0.1%	0.6%	0.7%
Total Gross Energy										
Trillion Btu	3,805.85	3,714.74	3,967.49	3,935.12	3,914.67	3,837.45	3,960.61	3,931.45	3,911.31	4,031.45

Note: Estimates (e) prepared by the Ohio Department of Energy.

Source: The Ohio Department of Energy.

Table 7 Gross Energy Consumption by Fuel, 1979

UNITED STATES



STATE OF CHIC

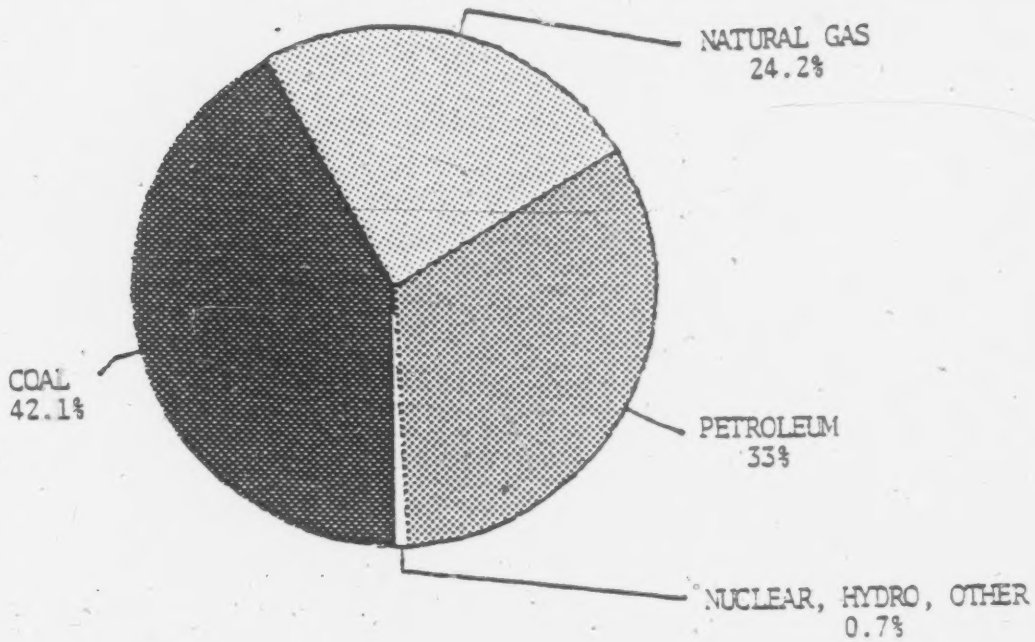


Table 8 Ohio Gross Energy Production by Fuel, 1970 - 1979

Year	Crude Oil (Thousand Bbls.)	Natural Gas (MMcf)	Coal (Thousand Short Tons)
1970	9,864	73,759	55,137
1971	9,670	82,678	49,017
1972	9,358	90,487	50,572
1973	8,796	94,121	45,666
1974	9,088	94,376	45,352
1975	9,578	85,810	46,673
1976	9,994	89,770	46,804
1977	10,359	99,656	46,940
1978	11,154	115,239	38,840
1979	11,953	124,665	41,877

Note: Natural gas production in 1979 includes an estimated 1,234 MCF produced and sold but not reported and gas utilized in the field.

Source: Summary of Ohio Oil and Gas Developments in 1979, Ohio Department of Natural Resources; and Division of Mines, Ohio Department of Industrial Relations.

Table 9 Ohio Resource Reserves by Fuel, 1970 - 1978

Year	Crude Oil (1000 Bbls.)	Natural Gas (MMcf)	Coal (Million Short Tons)
1970	127,912	557,455	*
1971	129,144	615,477	*
1972	127,385	715,151	*
1973	124,911	808,641	*
1974	123,871	960,662	41,166
1975	121,263	969,020	41,119
1976	125,268	1,025,950	41,073
1977	129,148	1,093,150	41,028
1978	131,648	1,177,000	49,063
1979	137,718	1,400,000	49,021

Note: The figure for 1979 natural gas is preliminary. Coal reserves are remaining identified resources; no data are available for years marked with asterisk (*). Coal reserve figures for 1975-1979 are ODOE estimates.

Source: Summary of Ohio Oil and Gas Developments in 1979, Ohio Department of Natural Resources; Coal Data 1976; and the Ohio Department of Energy.

Table 10 Average Cost of Fuels to End Users in the United States, 1973 - 1979 (1972 dollars)

Year	Leaded Regular Motor Gasoline		Residential Heating Oil		Residential Natural Gas		Residential Electricity	
	cent/gal	$/MMBtu	cent/gal	MMBtu	cent/mcf	$/MMBtu	cent/KWH	$/MMBtu
1973	36.5	2.92	N/A	N/A	121.2	1.19	2.39	7.00
1974	44.8	3.59	29.4	2.12	121.4	1.19	2.63	7.71
1975	43.7	3.50	29.3	2.11	132.8	1.30	2.73	8.00
1976	43.1	3.46	30.2	2.18	145.4	1.43	2.74	8.03
1977	43.2	3.46	31.2	2.25	162.2	1.59	2.80	8.20
1978	41.0	3.28	21.7	2.29	164.4	1.62	2.76	8.10
1979	49.8	3.98	40.8	2.94	185.3	1.88	2.66	7.79

Note: NA = Not Available

Source: Monthly Energy Review, April, 1980.

Table 11 Ohio Coal Use by Source, 1970 - 1979
(Thousand Short Tons)

Year	Total Exports	Western Coal	Eastern Coal*	Total Imports	Ohio Coal	Total Use
1970	19,584	-0-	31,822	31,822	35,553	67,375
1971	15,414	-0-	29,513	29,513	33,603	63,116
1972	15,422	-0-	32,665	32,665	35,130	67,795
1973	12,257	-0-	32,348	32,348	33,409	65,557
1974	12,308	1,172	35,426	36,598	33,044	69,642
1975	13,205	1,433	33,118	34,551	33,468	68,019
1976	11,403	3,372	32,191	35,563	35,401	70,904
1977	10,700	4,841	33,051	37,892	36,240	74,132
1978	8,133	4,700	32,504	37,204	30,707	67,912
1979	11,619	3,835	36,908	40,745	32,059	72,804

* Excludes Ohio

Note: Eastern Region includes Bituminous Coal and Lignite Producing Districts 1 - 13. Western region includes all other states except Ohio.

Source: Energy Data Report, Bituminous Coal and Lignite Distribution, Calender Year 1979, U. S. Department of Energy.

Table 12 Coal Reserves in Appalachian States

State	Total Identified Reserves (in millions of short tons)	BTU Equivalents in Quadrillions (10^{15})
West Virginia	100,150	2,503.750
Pennsylvania	82,752	2,068.800
Kentucky	64,346	1,608.650
OHIO	49,021	1,225.525
Alabama	15,262	381.550
Virginia	9,551	238.755
Tennessee	2,530	63.250
Maryland	1,152	28.800
North Carolina	110	2.750
Georgia	24	0.600
Total	324,898	8,122.450

Note: Identified resources are as of January 1, 1974, except Ohio. Ohio resources are as of January 1, 1980.

Source: Coal Data 1976 and the Ohio Department of Energy.

Table 13 Surface and Underground Production of Ohio Coal, 1972 - 1979
(Thousand Tons)

	1972	1973	1974	1975	1976	1977	1978	1979
Underground Production	16,301.8	16,209.4	14,415.5	15,469.3	16,707.6	14,004.2	11,389.2	13,540.3
Surface Production	34,269.8	29,457.1	30,936.1	31,203.6	30,096.3	32,936.0	28,705.0	29,318.7
Total Production	50,571.6	45,666.5	45,351.6	46,672.8	46,803.9	46,940.1	40,094.2	42,858.0

Source: Ohio Bureau of Industrial Relations, Division of Mines.

Table 14 New and Expanded Ohio Coal Mines, 1979 - 1988

Company/Division	Mine Name and County Location	Deep (D) or Strip (S)	Present Capacity (Mill. Tons)	Additions to Capacity by Years (Millions of Tons)									
				1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Horizon Coal Co.	Roseville-Muskingum	S	0.10	0.15	0.05	----	----	----	----	----	----	----	----
Pittsburg & Midway Coal Mining	Paw Paw Creek-Washington	D	----	----	----	----	----	----	----	----	----	----	0.80
Quarto Mining Co.	Powhatan 4-Monroe	D	1.10	1.60	0.30	----	0.20	----	----	----	----	----	----
Quarto Mining Co.	Powhatan 4-Monroe	D	0.30	0.80	0.30	----	0.10	----	----	----	----	----	----
Saginaw Mining Co.	Saginaw-Belmont	D	0.50	0.20	0.20	----	----	----	----	----	----	----	----
Southern Ohio Coal Co.	Meigs 1-Meigs	D	0.90	----	0.20	0.20	0.10	----	----	----	----	----	----
Southern Ohio Coal Co.	Meigs 2-Meigs	D	1.90	----	0.20	0.20	0.10	----	----	----	----	----	----
Southern Ohio Coal Co.	Racoon 3-Vinton	D	0.90	----	0.10	0.10	----	----	----	----	----	----	----
Youghiogheny & Ohio Coal Co.	Cadiz Portal-Harrison	D	0.25	0.25	----	0.25	0.25	0.25	----	----	----	----	----
Youghiogheny & Ohio Coal Co.	Nelms 2-Harrison	D	0.80	0.10	0.10	0.10	0.10	----	----	----	----	----	----
Youghiogheny & Ohio Coal Co.	Allison-Belmont	D	0.80	0.10	0.10	0.10	0.10	0.10	----	----	----	----	----
Total Ohio			7.65	3.20	1.55	0.95	0.95	0.35	---	---	---	---	0.80

Source: Coal Age, February 1980, p. 112

Table 15 Average Delivered Prices of Coal at Steam Electric Plants in Ohio (Cents per Million Btu)

	Average Contract Price	Average Spot Price
1973	41.5	44.6
1974	62.4	119.8
1975	89.6	104.5
1976	96.0	90.2
1977	104.1	96.8
1978	128.3	117.5
1979	136.9	121.5

Source: Annual Summary of Cost and Quality of Steam-Electric Plants 1973, 1974, 1975 and 1976, FPC; Report of Fuel Cost Quality, FPC Issues January-December, 1977; Cost and Quality of Fuels for Electric Utility Plants, 1978 and 1979, U.S.D.O.E.

Table 16 Sources of Gas Supply for Ohio Natural Gas Utilities, 1979
(Annual Purchases in MCF)

Company	Interstate	Ohio Production	Green Springs	Other and Storage	Total
Cincinnati Gas & Electric	84,827	2,193	6,205	153	93,378
Columbia Gas of Ohio	326,589	6,382	23,825	(699)	356,097
Dayton Power and Light	63,054	-------	4,393	------	67,447
East Ohio Gas	325,951	53,592	------	64,428	443,971
National Gas & Oil	8,473	5,325	------	802	14,600
Ohio Gas	6,632	683	------	361	7,676
River Gas	3,216	1,728	------	------	4,944
West Ohio Gas	14,151	------	940	------	15,091
Total	832,893	69,903	35,363	65,044	1,003,204
Percentage of Total	83.0%	6.9%	3.5%	6.4%	100.0%

Note: Parentheses indicate net loss through exchange.

Source: Monthly reports of eight major Ohio gas utilities.

Table 17 Actual (1978) and Projected Natural Gas Consumption by Standard Industrial Classification Code (MMcf)

	SIC 20	SIC 28	SIC 29	SIC 30	SIC 32	SIC 33	SIC 34	SIC 35	SIC 36		
	Food and Kindred Products	Chemical and Allied Products	Coal and Petroleum Products	Rubber and Misc. Plastics	Clay, Glass and Stone Products	Primary Metals	Fabricated Metal Products	Non-Electrical Machinery	Electrical, Electronic Machinery	All Other Industrial	Total Industrial
1978	11,523	38,995	9,155	6,794	45,125	127,084	27,176	5,392	7,209	30,694	309,148
1980	13,866	50,673	11,612	7,633	54,839	144,393	32,436	6,446	6,980	37,155	365,017
1985	15,822	57,455	13,044	8,421	61,684	161,936	36,331	7,107	7,865	41,685	411,405
1988	16,898	60,985	13,901	8,980	65,216	174,588	38,631	7,555	8,375	44,326	439,455

Source: 1979 Ten Year Forecasts of eight major Ohio gas utilities.

Table 18 Comparison of AGA Low Supply and High Supply Gas Volumes from Supplemental Sources for United States

Gas Volume in Forecast Year, Tcf

	1980		1985		1990	
Source	Low Supply	High Supply	Low Supply	High Supply	Low Supply	High Supply
Canadian and Mexican Imports	1.0	1.8	1.0	2.1	1.0	2.1
Substitute Natural Gas	0.3	0.5	0.3	0.9	0.3	0.9
Liquified Natural Gas	0.6	0.6	0.6	1.6	0.6	2.4
Coal Gas	-	-	-	0.2	-	1.2
New Technologies*	-	-	-	0.1	-	0.5
Alaskan	-	-	-	0.8	-	1.6
Total Supplementals	1.9	2.9	1.9	5.7	1.9	8.7

* "New Technologies" include the following sources: Devonian shale, tight sands, geopressured gas, gas from coal seams, biomass gas from biological waste and peat gasification.

Note: These tables were extracted from a report in Gas Energy Review, February 1979, entitled "A Forecast of the Economic Demand for Gas Energy in the U.S. through 1990." AGA staff have since revised their forecasts on supplemental and total supplies, but habe not shown "Low Supply" and "High Supply" forecasts as they did in 1979. Subsequent forecasts show little change in the volumes for supplemental sources. Updated forecasts can be found in Gas Supply Review, February 1980, American Gas Association.

Table 19 Transmission of Self-Help Gas in Ohio, 1973-1979
(MMCF)

1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979
81.88	649.24	795.89	5,271.34	9,327.38	9,604.21

Note: Contract year is from November 1 through October 31.

Source: Public Utilities Commission of Ohio.

Table 20 New Ohio Electricity Generating Facilities Proposed Through 1990

Company	Unit	Type	Size (MW)	Date	Location
CAPCO	Bruce Mansfield 3	Coal	780	1980	Shippingport, PA
CAPCO	Zimmer 1	Nuclear	792	1981	Moscow, OH
CGE, DPL	East Bend 2	Coal	600	1981	Kentucky
OP	Racine 1,2	Hydro	40	1981	Racine, OH
DPL, CGE	Killen 2	Coal	600	1982	Wrightsville, OH
Columbus	Municipal 1-3	Coal, Trash	90	1982	Columbus, OH
CAPCO	Perry 1	Nuclear	1205	1984	North Perry, OH
C&SOE	Walnut	Oil	280	1984	Groveport, OH
	or				
	Hayden	Natural Gas	280	1984	Amlin, OH
CGE, DPL	East Bend 1	Coal	600	1985	Kentucky
OP	Gallipolis	Hydro	40	1985	Eureka, OH
DPL, CGE	Killen 1	Coal	600	1985	Wrightsville, OH
CAPCO	Beaver Valley 2	Nuclear	830	1986	Shippingport, PA
C&SOE	Poston 5	Coal	375	1987	Athens, OH
CAPCO	Perry 2	Nuclear	1205	1988	North Perry, OH
Buckeye	Peaking	Oil/Natural Gas	300-450	1989	State Planning Region 6
	or				
	Coal Fired	Coal	600-750	1989	State Planning Region 7
CGE, DPL	East Bend 3	Coal	600	1989	Kentucky
C&SOE	Newbury	Coal	750	?	Washington County
	or				
	Great Bend	Coal	750	?	Meigs County
C&SOE	Poston 6	Coal	375	1990	Athens, OH

Note: Size indicated is the net expected capability.

Source: FPC Form 12E-2, and the Ten Year Forecasts of the Ohio electric utilities.

Table 21 Electric Energy Transferred To and From Ohio in 1979
(Megawatt Hours)

	From Ohio	To Ohio
Cincinnati Gas & Electric	2,494,468	649,132
Cleveland Electric Illuminating	377,070	759,065
Columbus & Southern Ohio Electric	0	0
Dayton Power & Light	0	0
Duquesne Light	2,925,018	670,794
Monongahela	0	2,144,320
Ohio Edison	1,510,647	1,773,871
Ohio Power	30,523,488	29,149,520
Ohio Valley Electric Cooperative	1,455,401	4,502,507
Toledo Edison	825,410	2,510,667
TOTAL	40,111,502	42,159,876

Ohio was a net importer of 2,048,374 mWh's of electricity in 1979.

Source: FPC Form 12, Schedule 11, of Ohio electric utilities.

Table 22 Actual (1978 and 1979) and Projected Electricity Consumption by Standard Industrial Classification (SIC) Code (Gigawatt Hours/Year)

	SIC 11-12	SIC 20	SIC 22	SIC 26	SIC 27	SIC 28	SIC 29	SIC 30
	Coal Mining	Food and Kindred Products	Textile Mill Products	Paper . Allied and Products	Printing/ Publishing	Chemicals & Allied Products	Coal and Petroleum Products	Rubber and Misc. Products
1978	558.7	1,413.5	148.6	1,742.9	412.7	3,516.4	1,809.0	2,292.2
1979	660.8	1,458.9	151.9	1,774.5	420.4	3,690.6	1,883.6	2,241.9
1980	709.8	1,507.7	159.5	1,835.8	441.8	3,877.8	1,974.5	2,317.9
1985	925.9	1,788.5	193.3	2,126.5	555.2	5,557.7	2,548.6	2,809.4
1988	1,084.9	2,124.0	215.3	2,316.5	632.5	6,647.7	3,040.6	3,167.3

Source: 1980 Ten Year Forecasts of Ohio's electric utility companies.

Table 22 (Cont.) Actual (1978 and 1979) and Projected Electricity Consumption by Standard Industrial Classification (SIC) Code (Gigawatt Hours/Year)

	SIC 32	SIC 33	SIC 34	SIC 35	SIC 36	SIC 37		
	Clay, Glass and Stone Products	Primary Metals	Fabricated Metal Products	Machinery	Electric Machinery	Transportation Equipment	All Other Industrials	Total Industrial
1978	232.0	22,345.7	2,389.0	2,066.4	2,130.0	4,318.3	16,884.4	64,348.8
1979	2,327.7	23,548.1	2,943.3	2,248.5	2,139.8	4,412.6	17,596.4	67,049.1
1980	2,411.2	24,102.0	2,607.3	2,387.7	2,238.7	4,571.7	10,584.2	61,727.5
1985	2,929.4	27,834.1	3,275.0	3,016.8	2,763.5	5,541.0	21,063.6	82,928.6
1988	3,283.8	30,487.0	3,652.3	3,393.3	3,087.6	6,135.2	21,689.6	90,957.7

Source: 1980 Ten Year Forecasts of Ohio's electric utility companies.

Table 23 Typical Monthly Residential Electric Bills in Ohio

	1974		1975		1976		1977		1978		1979	
	500 kWh	Cents Per kWh	500 kWh	Cents Per kWh	500 kWh	Cents Per kWh	500 kWh	Cents Per kWh	500 kWh	Cents Per kWh	500 kWh	Cents Per kWh
Cambridge	$11.75	2.35¢	$14.62	2.92¢	$16.02	3.20¢	$16.00	3.20¢	$18.60	3.72¢	$19.31	3.86¢
Percent Change from Previous Year	+15.88%		+24.43%		+ 9.58%		-.12%		+16.25%		+ 3.82%	
Cincinnati	12.18	2.44	14.78	2.96	14.23	2.85	18.54	3.71	19.62	3.92	19.52	3.90
Percent Change from Previous Year	+ 3.48%		+21.35%		- 3.72%		+30.29%		+ 5.83%		- .51%	
Cleveland	12.79	2.56	19.79	3.96	20.19	4.04	24.18	4.84	25.54	5.11	26.47	5.29
Percent Change from Previous Year	+ 2.08%		+54.73%		+ 2.02%		+19.76%		+ 5.62%		+ 3.64%	
Columbus	13.41	2.68	18.30	3.66	19.63	3.93	22.51	4.50	22.26	4.45	26.05	5.21
Percent Change from Previous Year	+ 1.21%		+36.47%		+ 7.27%		+14.67%		- 1.11%		+17.03%	
Toledo	12.85	2.57	15.15	3.03	20.69	4.14	24.57	4.91	25.95	5.19	30.67	6.13
Percent Change from Previous Year	+19.09%		+12.85%		+36.57%		+18.75%		+ 5.62%		+18.19%	

Source: Typical Electric Bills 1973, 1974, 1975, 1976, 1977, 1978, 1979 and the Ohio Department of Energy.

Table 24 Electric Generating Capacity Serving Ohio, 1979 - 1980 (Megawatts)

	1979	1980	1985	1990
Coal	27,993	28,743	31,143	31,807
Oil and Gas (baseload)	692	692	641	641
Oil and Gas (peaking units)	1,306	1,306	1,543	1,622
Nuclear	1,155	1,155	3,167	5,219
Hydro, Pumped Storage	330	330	330	330
Total	31,476	32,226	36,824	39,619

Note: 1980, 1985 and 1990 figures include existing and projected capacity.

Source: Ohio Electric Utilities' Ten Year Forecasts.

Table 25 Estimated Proved Reserves of Crude Oil
1970 - 1979

(Thousands of Barrels)

Year	United States	World	U.S. as a percent of World Total
1970	29,631,862	530,534,067	5.6
1971	39,001,335	611,195,133	6.4
1972	38,062,957	632,553,494	6.0
1973	36,339,408	664,219,559	5.5
1974	35,299,839	626,706,479	5.6
1975	34,249,956	712,418,535	4.8
1976	32,682,127	657,920,849	5.0
1977	30,942,166	640,089,568	4.8
1978	29,486,402	645,805,194	4.6
1979	27,803,760	640,907,585	4.3

Figures include 9.6 billion barrels in Prudhoe Bay, Alaska (discovered in 1968) which were not available for production prior to 1977 due to lack of transportation facilities.

Source: Basic Petroleum Data Book, American Petroleum Institute.

Table 26 United States Drilling Activity

	Well Completions		Rig Count
Year	Total Wells	Wildcats	(Cumulative Average)
Jan. - May, 1978	18,363	4,114	2,031
Total 1978	48,513	10,677	2,259
Jan. - May, 1979	18,797	3,808	2,031
Total 1979	51,029	10,379	2,181
Jan. - May, 1980	22,213	4,419	2,667

Source: Oil and Gas Journal, American Gas Association.

Table 27 Average U. S. Gasoline Prices, 1973 - 1979
(cents/gallon)

Year	Leaded Regular Full Serve	Leaded Regular Self Serve	Unleaded Regular Full Serve	Unleaded Regular Self Serve
1973	39.0	NA	NA	NA
1974	52.8	NA	NA	NA
1975	56.2	55.1	59.8	NA
1976	58.7	55.4	62.5	NA
1977	62.6	58.2	66.4	63.6
1978	63.9	59.8	68.4	64.9
1979	86.5	83.0	92.2	88.6
1980	121.3	116.8	125.9	122.2

Note: Prices include taxes. Prices for 1980 are as of March.

Source: Monthly Energy Review and Energy Data Report, Gasoline Prices, U.S. Department of Energy.

Table 28 Ratio of Ohio Energy Use to Gross State Product, 1974 Through 1978

(MM Btu/GSP in 1972 Dollars) x 100

	1974	1975	1976	1977	1978
Total Ohio Energy Use/GSP	6.41	6.52	6.33	6.00	5.75
Ohio Industrial Energy Use/GSP	2.43	2.20	2.17	2.04	1.93

Source: Ohio Department of Economic and Community Development and the Ohio Department of Energy.